

FREING WATER FROM VIRUSES AND BACTERIA

ORIGINATING TECHNOLOGY/ NASA CONTRIBUTION

Four years ago, [Argonide Corporation](#), a company focused on the research, production, and marketing of specialty nano materials, was seeking to develop applications for its NanoCeram® fibers. Only 2 nanometers in diameter, these nano aluminum oxide fibers possessed unusual bio-adhesive properties. When formulated into a filter material, the electropositive fibers attracted and retained electronegative particles such as bacteria and viruses in water-based solutions. This technology caught the interest of NASA as a possible solution for improved water filtration in space cabins.

PARTNERSHIP

NASA's Johnson Space Center awarded Sanford, Florida-based Argonide a Phase I **Small Business Innovation**

Research (SBIR) contract to determine the feasibility of using the company's filter for purifying recycled space cabin water. Since viruses and bacteria can be carried aboard space cabins by space crews, the ability to detect and remove these harmful substances is a concern for NASA. The Space Agency also desired an improved filter to polish the effluent from condensed and waste water, producing potable drinking water.

During its Phase I partnership with NASA, Argonide developed a laboratory-size filter capable of removing greater than 99.9999 percent of bacteria and viruses from water at flow rates more than 200 times faster than virus-rated membranes that remove particles by sieving. Since the new filter's pore size is rather large compared to other membranes, it is also less susceptible to clogging by small particles. In September 2002, Argonide began a Phase II SBIR project with Johnson to develop a full-size cartridge capable of serving a full space crew. This effort,

which is still ongoing, enabled the company to demonstrate that its filter media is an efficient absorbent for DNA and RNA.

PRODUCT OUTCOME

Argonide supplies NanoCeram as laboratory-size filter discs and in the form of a syringe filter. The filter's unique character can be demonstrated by its ability to remove particulate dyes such as Metanyl yellow. Although Metanyl yellow's particle size is only 2 nanometers—approximately the size of a DNA molecule—the NanoCeram syringe filter is capable of retaining it as the fluid is passed through the syringe without much back pressure. Another distinctive advantage is the filter's ability to remove greater than 99.96 percent of endotoxins. As a contaminant formed from the residue of destroyed bacteria, endotoxins can cause toxic shock and present a major concern in pharmaceutical products.

Named one of the top 100 most technologically significant new products of 2002 by R&D Magazine, Argonide's NanoCeram syringe filters and laboratory filter discs provide the biotechnology and life science industries with fast, accurate, and cost-effective tools for separating proteins and other macromolecules. NanoCeram's key applications include sterilizing pharmaceuticals and medical serums; filtering DNA, RNA, and endotoxins; and immobilizing bacteria and mammalian cells in biosynthesis. The filters are capable of sterilizing water from all microbiological pathogens, including biological warfare weapons. Since the filter's absorption is based on the ionic charge of the macromolecules, the potential exists for separating proteins and other particulates on the basis of their charge differences. The separation of specific proteins signifies a major new thrust in biotechnology.

The NanoCeram® syringe filters and laboratory filter discs are fast, accurate, and cost-effective tools for separating proteins, viruses, and other macromolecules.





Argonide's innovation may also be applied to tissue engineering, as the NanoCeram fibers have also been found to simulate new bone growth. When the material is grafted into damaged bone, the fibers attract and retain bone cells, permitting new growth at higher rates than hydroxyapatite, a natural bone mineral. Since the fibers mimic the natural fibrous hydroxyapatite's shape and adhesion, the result is a healthy new bone with physical properties almost identical to the patient's original bone. This application may help patients suffering from forms of osteosarcoma, osteoporosis, and sclerosteosis, a disorder in which progressive bone overgrowth leads to facial deformities.

Since the principal application of the NanoCeram filters is based on their ability to remove viruses from water, the filter cartridge Argonide is developing through its Phase II SBIR contract has many potential applications in water purification. For example, although municipal water is monitored for bacterial contamination on a routine basis, viruses are not monitored and there are no regulations for their removal. This is primarily due to the difficulty in monitoring for specific virus contamination. A low-cost filter cartridge such as Argonide's could be used for sampling viruses, allowing for a more routine analysis of municipal water treatment plant sources and effluents.

The NanoCeram® technology enables filter sterilization of medical serums and biological fluids.

This potential application presents significant benefits, since viral hepatitis A and Norwalk virus epidemics have been waterborne on numerous occasions. Recent studies have shown that viruses can percolate far further underground than bacteria and can contaminate ground water supplies as a result.

The threat of terrorists contaminating water supplies is also increasing the need for a water filtration system with NanoCeram's capabilities. Argonide has received a contract to develop a concentrator that would collect biological agent viruses from water for the purpose of detection by real-time sensors. In another program, Argonide has demonstrated efficient collection of viruses containing aerosols, for the purpose of identifying aerosolized pathogens.

For consumers, Argonide is also developing a polishing filter that would be used in portable water purification devices for campers, backpackers, and military personnel. Present devices, while capable of filtering bacteria from water, are unable to filter viruses. Adding a NanoCeram polishing filter to the effluent of an existing filtration device could remove more than 99.99 percent of viruses. Another application is a point-of-use filter for residences with either municipal or pumped well water. On a global level, Argonide is working on low-cost gravity filters that might be used to purify surface or well water in Third World countries.

NanoCeram® is a registered trademark of Argonide Corporation.